NEXT Endstation Capability Plan for Initial Science Program
October 2015

One recommendation made by the Management subcommittee of the September 2012 DOE/OPA review of NEXT was: *"Create an endstation capability analysis and update it annually."* Version 1 of this plan was written in January 2014 and posted for the March 2014 DOE review of NEXT, for CD-3. It was updated in August 2014 (version #2) to capture changes from January through July 2014 and in March 2015 (version #3) to captures changes from July 2014 through March 2015. The present version (#4) is another update to capture changes since March 2015.

The plan presented in this document summarizes the endstation capabilities provided in the base scope of each NEXT beamline and the associated scientific capabilities they support. The plan ensures that the project baseline will provide endstation capabilities to support a first-rate, productive initial science program.

Our goal in developing the NEXT baseline is to provide each beamline with a minimum of one endstation outfitted with the best available components in order to provide the capabilities required to optimally serve the initial science program. This plan achieves that goal fully for all five of the base-scope NEXT beamlines (ESM, ISR, ISS, SIX, and SMI).

Compared to the August 2014 version of this plan, the present version reflects the commitment of a significant amount of NEXT project contingency funds to enhance the capabilities of the five base-scope endstations (ESM, ISR, ISS, SIX, and SMI). As a result of this investment, the present version of this plan contains no identified PDS or endstation components vying for NEXT project contingency funding. The updated base scope endstation capabilities shown below address the DOE mission needs to be provided by NEXT and respond to the recommendations received at all DOE/OPA reviews of NEXT held to date.

We fully expect the NEXT beamline scientific programs to evolve over time and this may create future requirements for endstations or endstation components that are not fully provided in NEXT project base scope. In these cases, we will upgrade the endstations at such time as the future requirements become clear, which will most likely be during operations.

A summary description of the endstations included in the NEXT Project base scope and the initial science capabilities they support is given below in tabular form for each beamline. An additional table for some beamlines lists components being provided via approved and executed Partner User Agreements.

Each beamline description begins with a table listing design parameters for that beamline, organized by photon delivery branches and endstations.

ESM – Electron Spectro-Microscopy

A high level summary of the ESM photon delivery system performance parameters is provided below.

	Endstation	Energy Range (keV) Energy Resolution	Spot Size (VxH μm^2)	Flux (photons/s)	Threshold Scope
ESM	Main Branch				Y
	μ-ARPES	0.015–1.5, $\geq 10^{-5}$	1×1	$\geq 1\times10^{10}$	Y
	AC-XPEEM	0.015–1.5, $\geq 10^{-5}$	36×6	$\geq 1\times10^{11}$	N*

* Infrastructure for this endstation included in NEXT baseline scope.

Descriptions of the base scope endstations for the ESM beamline, and the techniques and capabilities they will enable, are given below.

Primary ESM endstation: μ-ARPES experiments, including high-resolution band mappings from micron-size samples, e.g. “small” single crystals of newly synthesized multi-element materials, single grains of polycrystalline materials, single domains of magnetic materials, and micron-size electronic devices. μ-ARPES experiments will be ideally served by the ESM beamline, providing a high-resolving power (<1 meV up to 100 eV, < 50 meV up to 1 keV, and < 100 meV up to 1.5 keV), wide photon energy range (15 – 1500 eV), variable light polarization (linear horizontal, linear vertical, and circular), and microfocused beam (<1 μm above 60 eV) using only mirror optics.

Base scope components of the μ-ARPES endstation are listed in the table below.

ESM μ-ARPES endstation, base scope		
Component	Description	Techniques/Capabilities
Electron energy analyzer	Scienta model DA30 electron energy analyzer with double mini-Mott spin detector for vectorial analysis of the spin polarization.	High energy- and k-resolution ARPES studies, either with or without spin resolution.
Sample manipulator & scanning stage	Three closed-circuit LHe cryostats; micro-precision sample stage with magnetic coils; nano-precision piezo scanning stage. Low-T stage with sample directly in contact with the cryostat with limited degrees of freedom	ARPES microscopy with 1 micron lateral resolution, with temperature as low as 15K
Sample preparation/modification tools	Surface Science instruments: e-beam evaporators, LEED, sputter gun, RGA, load-lock chamber	Preparation and characterization of single crystal surfaces and ultra-thin films

Presently no μ-ARPES endstation components are included in the NEXT contingency spend plan.

Second ESM endstation: The ESM photon delivery system includes, in base scope, optics (two mirrors) to serve a second endstation, along with requisite infrastructure (utilities, safety systems). The optical configuration has been designed to match optimally an Aberration-Corrected Soft X-ray Photoemission Electron Microscopy (AC-XPEEM). This full-field technique is complementary to μ-ARPES, with considerably higher lateral resolution (~10 nm). Electron diffraction provides fundamental structural information of the system under investigation and core level spectroscopy makes the technique highly element specific. The use of circular polarization contrast in combination with absorption contrast makes the technique sensitive to magnetic structures. AC-XPEEM will be ideally served by the ESM beamline, providing high-flux ($>10^{11}$ ph/sec) over a wide photon energy range (15 – 1500 eV) with a moderately focused beam (VxH=36 μm × 6 μm, corresponding to ~ 36 μm x 36 μm projected on the sample surface in measurement conditions).

Presently no ESM second endstation components are included in the NEXT base scope or contingency spend plan.

FXI – Full-field X-ray Imaging

A high level summary of the FXI photon delivery system performance parameters is provided below.

	Endstation	Energy Range (keV) Energy Resolution	Spot Size (VxH μm²), mode	Flux (photons/s)	Threshold Scope
FXI	Main Branch (design only)				N
	TXM	5-11, 1.3×10^{-4}	40 μm FOV, 30 nm res.	5×10^{13} @ 10 keV	N

The design of the FXI photon delivery system is included in NEXT base scope. Specifically, NEXT base scope includes (i) design of the beamline photon delivery system (PDS) and (ii) detailed design and procurement (fabrication, installation) of the shielded enclosures (hutches). Procurement, fabrication, installation, and testing of the FXI PDS is not included in NEXT scope. The FXI endstation consists, at a basic level, of the Transmission X-ray Microscopy (TXM) endstation owned by the NSLS-II facility. This endstation, when coupled to the FXI PDS, will provide a state-of-the-art beamline for full-field x-ray imaging. Upgrade of the endstation to support a fast detector would enhance its performance even further. Endstation upgrade activities are not included in NEXT scope.

Descriptions of the FXI endstation and the techniques and capabilities it will enable are given below.

FXI, the beamline for Full Field X-ray Imaging, is a hard x-ray microscopy beamline that will provide state-of-the-art implementations of a 30 nanometer resolution, high speed transmission x-ray microscope (TXM) for samples demanding the highest resolution. The TXM, purposely designed for XANES imaging, features a precise metrology system for automated tomography and interior tomography. Using a high-flux damping wiggler as the source, the FXI TXM is expected to deliver world-leading intensity.

The estimated increase in speed for the TXM at FXI is 24 times that of a similar instrument at APS beamline 32-ID-C and ~600 times that of the TXM at NSLS beamline X8C. The existing TXM endstation at NSLS X8C is available for use at FXI, and is capable of serving 5-11 keV x-ray energies, with high resolution (down to 30 nm) and large field of view (up to 40 µm). The area detector presently installed in the TXM at NSLS X8C can be upgraded with a next-generation area detector in order to utilize the high flux from the FXI beamline for high-speed imaging. FXI detector requirements have been finalized and discussions of fast imaging capabilities are underway with vendors of high-speed area detectors to determine the best commercial options. The cost for this upgrade has been estimated and the NSLS-II Controls group has estimated resource requirements and achievable schedule.

It is expected that NEXT may be able to provide affordances that could support FXI, primarily infrastructure items such as utilities (mechanical, electrical) and safety systems (PPS, EPS).

ISR – Integrated In-Situ & Resonant X-Ray Studies

A high level summary of the ISR photon delivery system performance parameters is provided below.

	Endstation	Energy Range (keV) Energy Resolution	Spot Size (VxH μm^2)	Flux (photons/s)	Threshold Scope
ISR	Inboard Branch				Y
	6-Circle Diffractometer	2.4-23, 1.3×10^{-4}	Variable down to 40 x 200	≥ 2×10^{12} @ 10 keV	Y
	Base Diffractometer #1	6–23, 1.3×10^{-4}	Variable down to 40 × 200	≥ 2×10^{12} @ 10 keV	N*
	Base Diffractometer #2	2.4–23, 1.3×10^{-4}	Variable down to 4 × 20	≥ 2×10^{12}@ 10 keV	N*
	Outboard Branch (design only)				N
	4-circle	~15, 1.3×10^{-4}	10's × 10's	10^{12}	N

* Infrastructure for this endstation included in NEXT baseline scope.

The primary goal of the ISR beamline is to illuminate the physics of materials for the 21st century, and the science case consists of three overlapping areas: novel ordering phenomena, atomic structure of functional surfaces and interfaces, and growth and materials processes. X-ray scattering techniques such as resonant x-ray scattering, crystal truncation rod measurements, x-ray reflectivity, grazing incidence small-angle x-ray scattering, and grazing incidence diffraction are required in order to improve our understanding of novel materials. Therefore the ISR beamline has been designed as an x-ray scattering beamline covering the 2.4–23 keV energy range that will enable the *in-situ* study of materials in a flexible range of environment chambers. Specialized optics will provide polarization control and microfocusing with a large (~1 m) working distance from the focusing optic.

Descriptions of the base scope endstations for the ISR beamline, and the techniques and capabilities they will enable, are given below.

Primary ISR endstation: ISR Hutch C will house a 6-Circle Diffractometer, used for general scattering,and Base Diffractometer #1.

Base scope components of the 6-Circle Diffractometer endstation are listed in the table below.

ISR 6-Circle Diffractometer endstation, base scope		
Component	Description	Techniques/Capabilities
6-circle diffractometer	Vertical and horizontal plane scattering with small sphere of confusion, large accessible Q range and dual 2θ arms for simultaneous mounting of area and point detectors	RXS, crystal truncation rod analysis, grazing incidence diffraction
Motorized xyz displex mount	Sub-micron resolution	Temperature-dependent studies

In-vacuum polarization analyzer	In-vacuum polarization analyzer reduces beam absorption from air and additional windows	RXS down to 2.4 keV
Detectors*	• Eiger 1M area detector • ADSC HF-130k area detector • Pilatus 100K area detector • Vortex silicon drift detector • AmpTek CdTe diode detector • Avalanche photodiode detector (APD) • Ion chambers	Area detectors, high and medium energy resolution (Vortex and AmpTek, respectively), large dynamic range (APD), and ion chambers.
Sample environment tool	Displex cryostat that mounts into diffractometer.	Sample temperatures between ~6 and 350 K.

* All detectors shared among ISR endstations.

Second ISR endstation: ISR Hutch C will also house Base Diffractometer #1, which can accommodate large, user-supplied magnets for studies of magnetic order and field-induced structural changes. All detectors listed above for the 6-Circle Diffractometer endstation are shared with this endstation.

Base scope components of the Base Diffractometer #1 endstation are listed in the table below.

ISR Base Diffractometer #1 endstation, base scope		
Component	Description	Techniques/Capabilities
Base diffractometer #1	Horizontal plane 2-circle on ±4° orthogonal arcs and xyz translation stages, which accommodates large user-supplied magnets. Conventional 2-circle analyzer and polarization analyzer.	RXS with effective “azimuthal” scans using polarization control and analysis, XMCD, and general scattering.
Detectors*	• Eiger 1M area detector • ADSC HF-130k area detector • Pilatus 100K area detector • Vortex silicon drift detector • AmpTek CdTe diode detector • Avalanche photodiode detector (APD) Ion chambers	Area detectors, high and medium energy resolution (Vortex and AmpTek, respectively), large dynamic range (APD), and ion chambers for XMCD.

* All detectors shared among ISR endstations.

Presently no Base Diffractometer #1 endstation components are included in the NEXT contingency spend plan.

Third ISR endstation: ISR Hutch D will house Base Diffractometer #2, which can accommodate large, user-supplied UHV chambers for in-situ studies of growth and processing. All detectors listed above for the 6-Circle Diffractometer and Base Diffractometer #1 endstation are shared with this endstation.

Base scope components of the Base Diffractometer #2 endstation are listed in the table below.

ISR Base Diffractometer #2 endstation, base scope		
Component	Description	Techniques/Capabilities
Base diffractometer #2	Vertical and horizontal plane scattering.	X-ray reflectivity, grazing incidence small angle scattering, and grazing incidence diffraction
Secondary focusing optics	KB mirror pair	Focusing down to 4 (V) x 20 (H) μm^2
Gas handling infrastructure	Gas cabinets and exhaust for variety of gases including laser gas for PLD growth	Growth and processing experiments
Detectors*	• Eiger 1M area detector • ADSC HF-130k area detector • Pilatus 100K area detector • Vortex silicon drift detector • AmpTek CdTe diode detector • Avalanche photodiode detector (APD) Ion chambers	Area detectors, high and medium energy resolution (Vortex and AmpTek, respectively), large dynamic range (APD), and ion chambers.

* All detectors shared among ISR endstations.

Presently no Base Diffractometer #2 endstation components are included in the NEXT contingency spend plan.

ISS – Inner Shell Spectroscopy

A high level summary of the ISS photon delivery system performance parameters is provided below.

	Endstation	Energy Range (keV) Energy Resolution	Spot Size (VxH μm^2), mode	Flux (photons/s)	Threshold Scope
ISS	Main Branch				Y
	X-ray Emission, X-ray Absorption	4.9–36 1.3×10^{-4} (Si(111) DCM), 2.7×10^{-5} (high res mono)	25×25 (spectrometer), 1000×1000 (standard), 3mm×60mm (unfocused)	$\geq 2 \times 10^{13}$ (4.9-25 keV)	Y

Descriptions of the base scope endstations for the ISS beamline, and the techniques and capabilities they will enable, are given below.

The Inner Shell Spectroscopy (ISS) beamline utilizes a damping wiggler hard X-ray source to serve a very broad user community, including energy science, life and environmental science, materials science, industrial applications, and more. The exceptional flux provided by an NSLS-II multipole wiggler enables science which greatly expands upon capabilities at existing spectroscopy beamlines. This includes (1) measurement of X-ray Absorption Spectroscopy (XAS) at ultra-low absorber concentration or sample volume, including systems of environmental, technological or other relevance, (2) high-resolution fluorescence detection for all XANES measurements, and (3) X-ray Emission Spectroscopy (XES). All ISS detectors and spectrometers will be designed to accommodate various *in-situ* sample environments, thus allowing for real measurements of real materials under real conditions. Taken together, this suite of spectroscopies provides a complete picture of inner-shell electronic structure and applies them to a broad, cross-disciplinary scientific mission.

Base scope components of the ISS endstation are listed in the table below.

ISS endstation, base scope		
Component	Description	Techniques/Capabilities
Sample chamber with integrated Z-1 filter and fluores-cence collection lens system	Sample chamber provides controlled sample environment, with: • up to 8 controllable gas streams • wide temperature range (77 – 873 K)	19 ports can be equipped with various fluorescence collection lenses and a Z-1 filter system. This provides: • scanning capabilities along the beam axis with 50μm-200μm spatial resolution • high background suppression of elastically scattered photons up $1:10^6$
XAFS Detector system	Each of the 19 ports will be equipped, via a sliding mechanism, with 2 types of detectors to measure the collected light: • Integrating PIN diode, • Silicon Drift Diode (SDD)	• Versatile high-performance conventional XAS (XANES and EXAFS), at large (1 mm), small (50-100 micron), and unfocused (5x60 mm) beam sizes; • XAFS and EXAFS on ultra dilute samples down to 1μmol concentration levels • Time-resolved and high-throughput XAS by fast energy scanning

Spectrometers. Each of the 19 chamber ports can be freely configured with one of the three types of spectrometers.	• Van Hamos spectrometer (initially 2) • Spherical Back Scattering Analyzers (each equipped with 5 4" crystals) – design only	• Time-resolved and high-throughput XAS by fast energy scanning • Moderate-resolution XES measurements • High energy resolution XANES utilizing XES spectrometer and energy refining monochromator • Time-resolved speciation measurements using dispersive X-ray Emission Spectroscopy (XES) spectrometer

Presently no ISS endstation components are included in the NEXT contingency spend plan.

Endstation components included in approved and executed Partner User Agreements related to ISS are listed in the table below.

ISS Spectroscopy endstation, Partner User Agreements			
PU	Component	Description	Techniques/Capabilities
Mark Chance (CWRU)	Roll-in endstation for biological XAS	• Translation and rotation stages needed to utilize ISS beam • lHe Displex cryostat (4.2K capable) • Advanced Ge fluorescence detector, most likely the existing 31-element Ge fluorescence detector from NSLS X3B)	• State-of-the-art biological XAS capability, e.g. of metalloproteins • High resolution local structure of biological systems

SIX – Soft Inelastic X-ray Scattering

A high level summary of the SIX photon delivery system performance parameters is provided below.

	Endstation	Energy Range (keV) Energy Resolution	Spot Size (VxH μm^2)	Flux (photons/s)	Threshold Scope
SIX	Main Branch				Y
	Inelastic Soft X-ray Scattering	0.165–2.3, $\geq 10^{-5}$	0.3×2.5	$\geq 1.5\times10^{11}$ @ 10^{-5} res'n, $\geq 8\times10^{12}$ @ 10^{-4} res'n	Y

Descriptions of the base scope endstation and emission spectrometer for the SIX beamline, and the techniques and capabilities it will enable, are given below.

The base scope for the Soft Inelastic X-ray Scattering (SIX) beamline includes beamline optics featuring an ultrahigh resolution monochromator with a resolving power of 10^5 at 1000 eV and an ultrahigh resolution inelastic scattering spectrometer capable of the same resolving power, for a combined resolving power of 70,000 at 1000 eV. The base scope optical components are being specified to meet these resolution goals.

Owing to the equal entrance and exit arm lengths in the optical design of the SIX spectrometer, the angle difference between the spectrometer focal plane and the optical axis is nearly 90° for the entire energy range of the beamline. However, achieving a combined resolving power of 70,000 will require to operate the detector at a more grazing incidence illumination of 25°, in order to increase the pixel-size-limit on the spectrometer resolving power. This decreases the photon energy range coverage for a given detector size and, most significantly, decreases detection efficiency at low energies.

CCD detectors can be made to have high efficiency in the soft x-ray range. For optimum sensitivity, these detectors must be back-illuminated with as thin a dead layer as possible. They have the nice advantage of a larger dynamic range than most competing detectors and are less susceptible to damage than microchannel plate (MCP) detectors. For these reasons, we are planning to use a CCD detector at SIX.

The ideal detector for the SIX beamline would be a soft x-ray CCD detector with increased sensitivity at grazing incidence and increased spatial resolution, such that it could be operated both in the spectrometer focal plane, i.e. at grazing incidence, and at higher angles when desired. For increased sensitivity at grazing incidence angles, the entrance window needs to be reduced to ~50 nm thickness. The spatial resolution needs to be 2 μm FWHM at 25°, or 5 μm FWHM at normal incidence. Such a detector is currently being produced for a soft X-ray spectrometer at the Swiss Light Source by the company XCAM (UK), and relies on a centroiding algorithm to achieve a demonstrated spatial resolution of 3 μm FWHM at normal incidence. SIX has placed an order for a similar detector with XCAM, with a delivery scheduled in August 2016. .

Base scope components of the SIX endstation are listed in the table below.

SIX endstation, base scope		
Component	Description	Techniques/Capabilities
Emission Spectrometer	• Rotates about the sample over a 120° angular range • Distance of 14.5 m from sample to detector	• Inelastic x-ray scattering spectra measured in ultrahigh or medium energy resolution mode, corresponding to combined resolving powers of respectively 70,000 and 20,000 at 1000 eV
Detector	• Commercially available soft x-ray CCD detector, viable efficiency down to grazing angles of 20°, spatial resolution of 5 μm (XCAM)	• Ability to operate over a large dynamic range. Compatible with ultrahigh energy resolution mode of spectrometer when tilted at 25°, albeit with lower efficiency than at normal incidence
Sample chamber	• UHV tank equipped with a six-axis sample manipulator and a cryostat • Triple rotating flange mechanism to enable rotation of the spectrometer arm without breaking ultra high vacuum	• Ability to position the sample onto center of rotation, and to cool the sample down to 15K

Presently no SIX endstation components are included in the NEXT contingency spend plan.

SMI – Soft Matter Interfaces

A high level summary of the SMI photon delivery system performance parameters is provided below.

	Endstation	Energy Range (keV) Energy Resolution	Spot Size (VxH μm2)	Flux (photons/s)	Threshold Scope
SMI	Inboard Branch				Y
	GISAXS	2.1–24 keV 1.3×10^{-4} (Si(111) DCM)	Ranges: 2.5×30 to 26×215	$\geq 10^{13}$	Y
	Liquid Surface Scattering	6.5–24 keV 1.3×10^{-4} (Si(111) DCM)	17×148	$\geq 8\times10^{12}$	N*
	Outboard Branch (design only)				N
	Liquid Surface Scattering	6.5–24 keV 1.3×10^{-4} (Si(111) DCM)	17×148	$\geq 10^{12}$	N

* Infrastructure for this endstation included in NEXT baseline scope.

The Soft Matter Interfaces (SMI) beamline will be optimized for grazing incidence x-ray diffraction (GIXD) and grazing incidence small/wide angle x-ray scattering (GISAXS/GIWAXS) on liquid/gas, liquid/liquid, solid/liquid and solid/gas interfaces. The inboard branch endstation (GISAXS/GIWAXS endstation, hutch 12-ID-C) will be optimized for simultaneous small and wide angle studies in the energy range from 2.1-24 keV. The GISAXS endstation will provide a full in-vacuum capability for windowless operation in order to study weakly scattering samples in the tender x-ray regime. Independent vertical and horizontal focusing mirrors will produce a 17(v)×148(h)µm focused spot at 50.9m from the source. This beam will undergo secondary focusing with refractive optics in the GISAXS endstation to provide the 2.5(v)×30(h)µm micro-focus for GISAXS. Alternatively the higher *q* resolution is obtained by primary focus to the GISAXS sample 59m from the source, which provides the 26(v)×215(h)µm, low divergence beam.

SMI also provides design and infrastructure for an additional endstation, hutch 12-ID-B. The design accommodates a double crystal beam deflector and horizontally scattering diffractometer that can be installed through a future funding path. The design efficiently utilizes the available space upstream of the GISAXS hutch, and the position of optimal primary beam focus by the SMI inboard mirrors serves a dual purpose by providing a focused spot at the sample position for the outboard line. Furthermore, the transition to full canted build-out can take advantage of an intermediate configuration in which time-sharing operation is enabled by placing 12-ID-B instrumentation onto the inboard x-ray beam. NEXT provides a shielded, interlocked, removable transport pipe in 12-ID-B to enable access into both hutches in the time-sharing configuration. NEXT also provides the interleaved photon delivery system design for canted build-out, $1M of PDS design and fabrication of masks, chambers, and stands for the outboard branch, utilities and cabling for 12-ID-B motor channels, and a second workstation and IOC.

The base scope detectors for the SMI endstations and the capabilities they will enable are given below.

Descriptions of the base scope endstations for the SMI beamline, and the techniques and capabilities they will enable, are given below.

Primary SMI endstation (12-ID-C): The GISAXS/GIWAXS endstation design enables windowless x-ray scattering measurements at x-ray energies from 2.1 to 24 keV. The endstation houses refractive optics for microfocus, and a sample vacuum chamber about 1 meter in dimension to enclose sample stages and a WAXS goniometer/detector system in high vacuum, connected to a vacuum SAXS flight path.

Base scope components of the GISAXS/GIWAXS endstation are listed in the table below.

SMI GISAXS/GIWAXS endstation, base scope		
Component	Description	Techniques/Capabilities
Integrated sample chamber for SAXS/GISAXS	• Sample chamber and associated hardware • Integrated detector goniometer for WAXS detection • Adjustable flight-path housing for GISAXS detection • Hexapods and rotation stage for sample positioning, having 13 degrees of freedom	• SAXS/GISAXS from soft matter samples, including liquid cells
Detectors	• Pilatus3 1M, customized for 2.1 keV and in-vacuum operation • Pilatus3 300K-W, customized for 2.1 keV	• Combined small- and wide-angle scattering, 2.1 to 24 keV • The resolution and sensitivity of these detectors are very well matched to the beam divergence

Presently no GISAXS/GIWAXS endstation components are included in the NEXT contingency spend plan.

GISAXS/GIWAXS endstation components included in signed and executed Partner User Agreements related to SMI are listed in the table below.

SMI GISAXS/GIWAXS endstation, Partner User Agreements			
PU	Component	Description	Techniques/Capabilities
Kevin Yager (BNL CFN)	Additional WAXS detector for high energy X-ray detection	Custom Rayonix CCD detector with fast 4-chip readout and evacuated through-hole for SAXS beam	Provides appropriate range and resolution for WAXS at energies > 8keV; provides full 360° azimuth of WAXS scattering in transmission and T-GISAXS samples.
Kevin Yager (BNL CFN)	Data acquisition software	Software architecture includes pipeline for sample alignment, measurement, batch processing, and sonification.	High throughput data acquisition, tailored for GISAXS/WAXS in soft-matter systems, commensurate with capabilities of detector suite

Second SMI endstation (12-ID-B): The Liquid Reflectometer design consists of the Single/Double Crystal Deflector, which steers the beam down onto a liquid surface for reflectivity measurements, the sample stage apparatus, and the detector apparatus.

Base scope components of the Liquid Reflectometer endstation are listed in the table below.

SMI Liquid Reflectometer endstation, base scope		
Component	Description	Techniques/Capabilities
Single/Double Crystal Deflector – design only	The beam steering mechanism is a custom design and will take advantage of the capabilities of the NSLS-II source and SMI photon delivery system.	Convertible between single and double steering design, with Ge(111) or dispersive Ge(111)/ Ge(220) configurations. Super high precision air bearing chi stage. Energy range 6.5–24 keV. Incident angle range to 12° in single crystal mode, 9° in double crystal mode. Energy/crystal dependent max q range > 2 Å^{-1} in most configurations.
Liquids sample/detector stage and arms – available for transfer. No refurbishment by NEXT.	• Transferred stage from NSLS beamline X22B	• Supports both single and double crystal deflection modes
Detectors – available via transfer from NSLS, will not be installed by NEXT	• Linear detector from NSLS X6B; Pilatus 100K area detector from NSLS X22B • Princeton CCD area detector (from NSLS beamline X13B)	• Reflectivity: linear detector resolution ~ 2.1mrad; area detector resolution ~ 5mrad • GISAXS detector resolution ~ 50 µrad

Presently no Liquid Reflectometer endstation components are included in the NEXT contingency spend plan.